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Burris et al.

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(54) **DOWNHOLE COMPONENT INCLUDING A UNITARY BODY HAVING AN INTERNAL ANNULAR CHAMBER AND FLUID PASSAGES**

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E21B 34/14 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 34/10*** (2013.01); ***E21B 34/14*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 34/10
See application file for complete search history.

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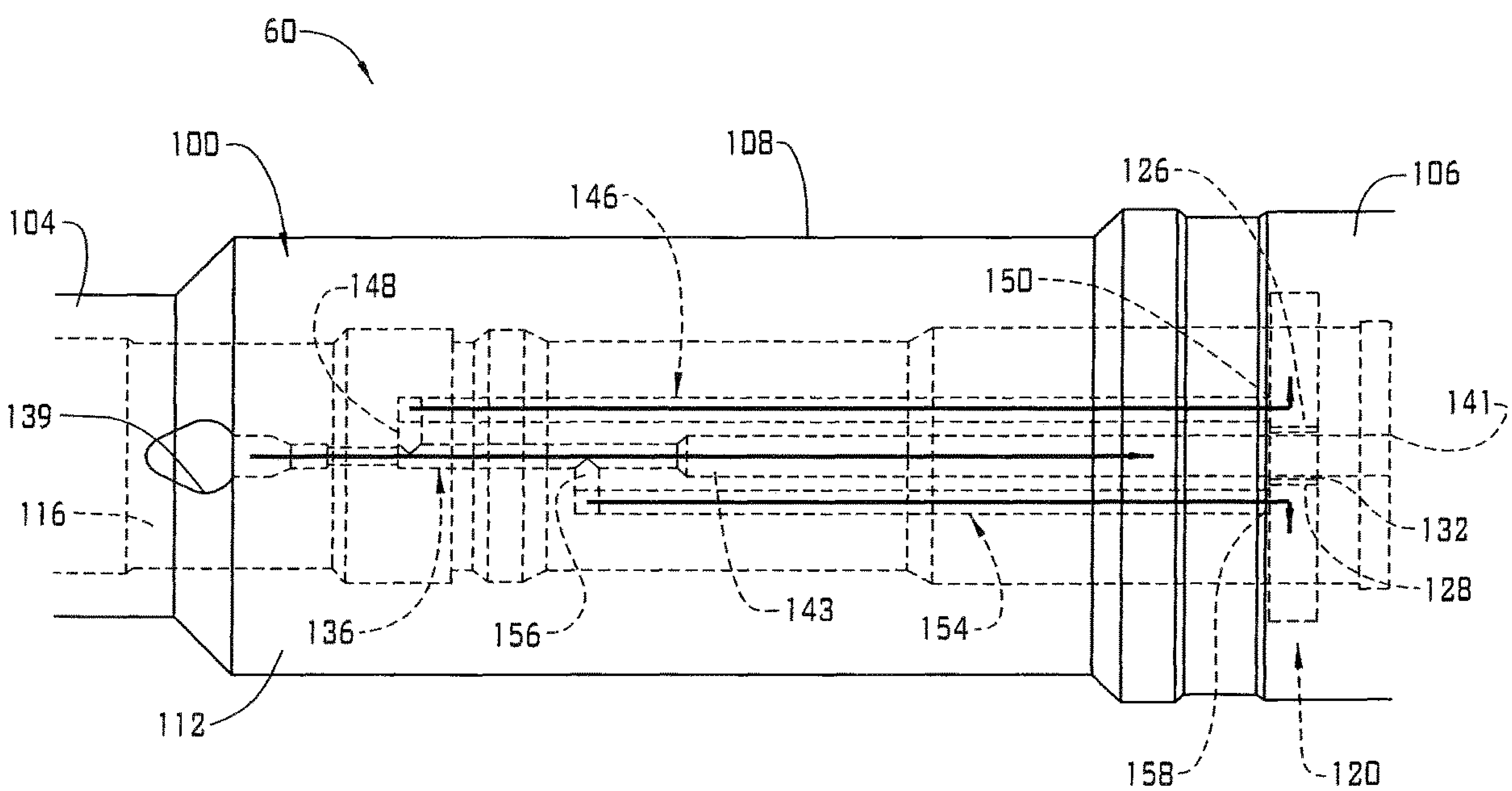
(57) **ABSTRACT**

A downhole component includes a unitary body having a first end portion, a second end portion and an intermediate portion extending therebetween. The intermediate portion defines an outer surface and an inner surface forming a flow path. An annular chamber has a first end section spaced from a second end section by a gap. The annular chamber is formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface.

17 Claims, 7 Drawing Sheets



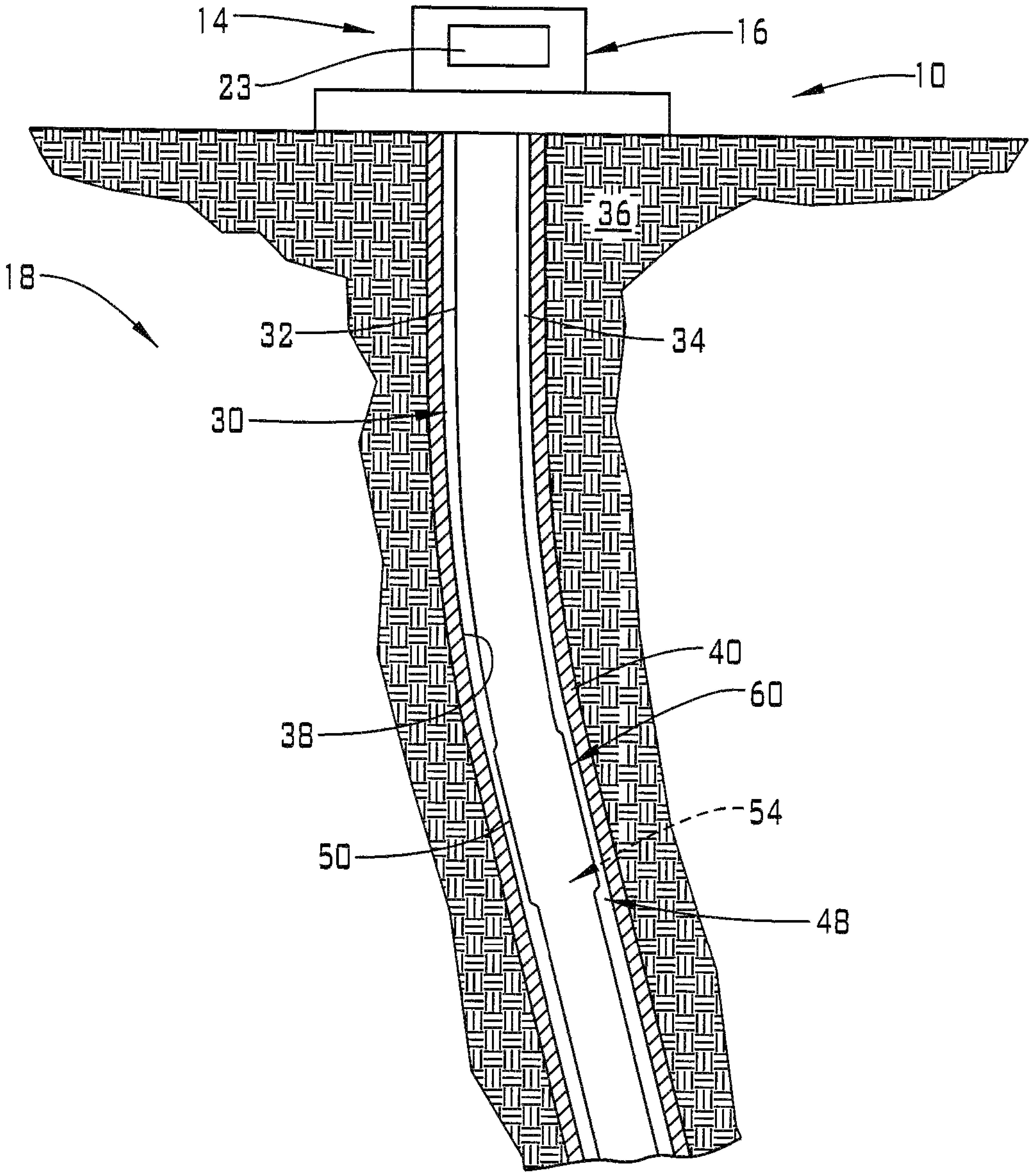


FIG. 1

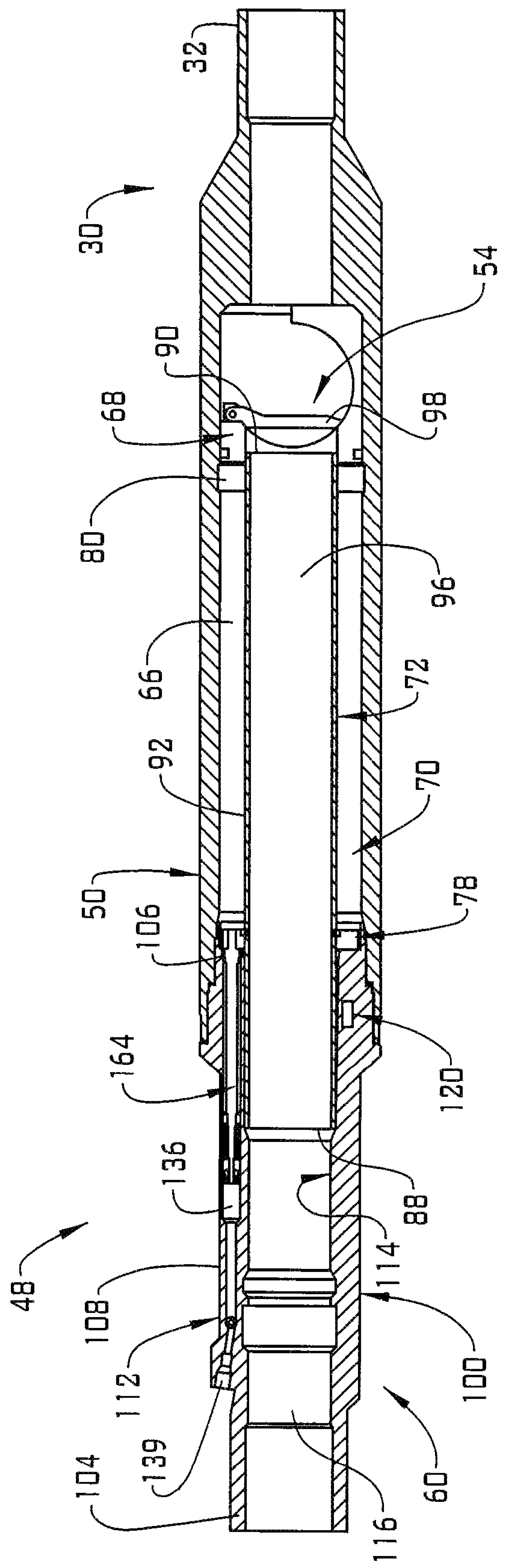

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FIG. 2

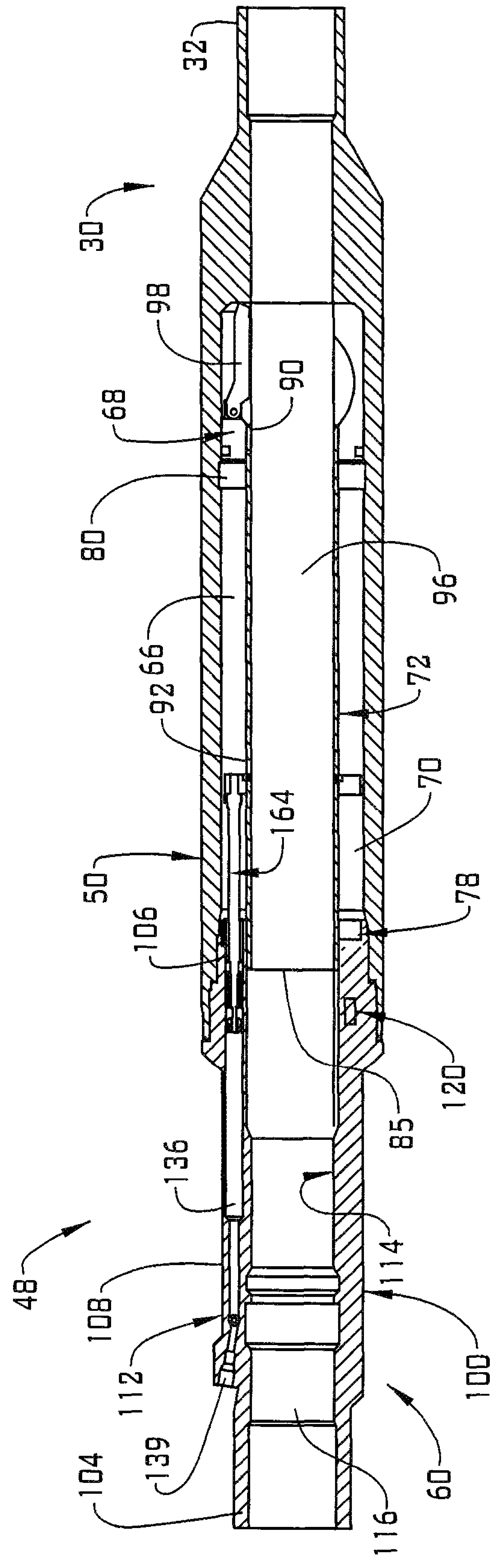
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FIG. 3

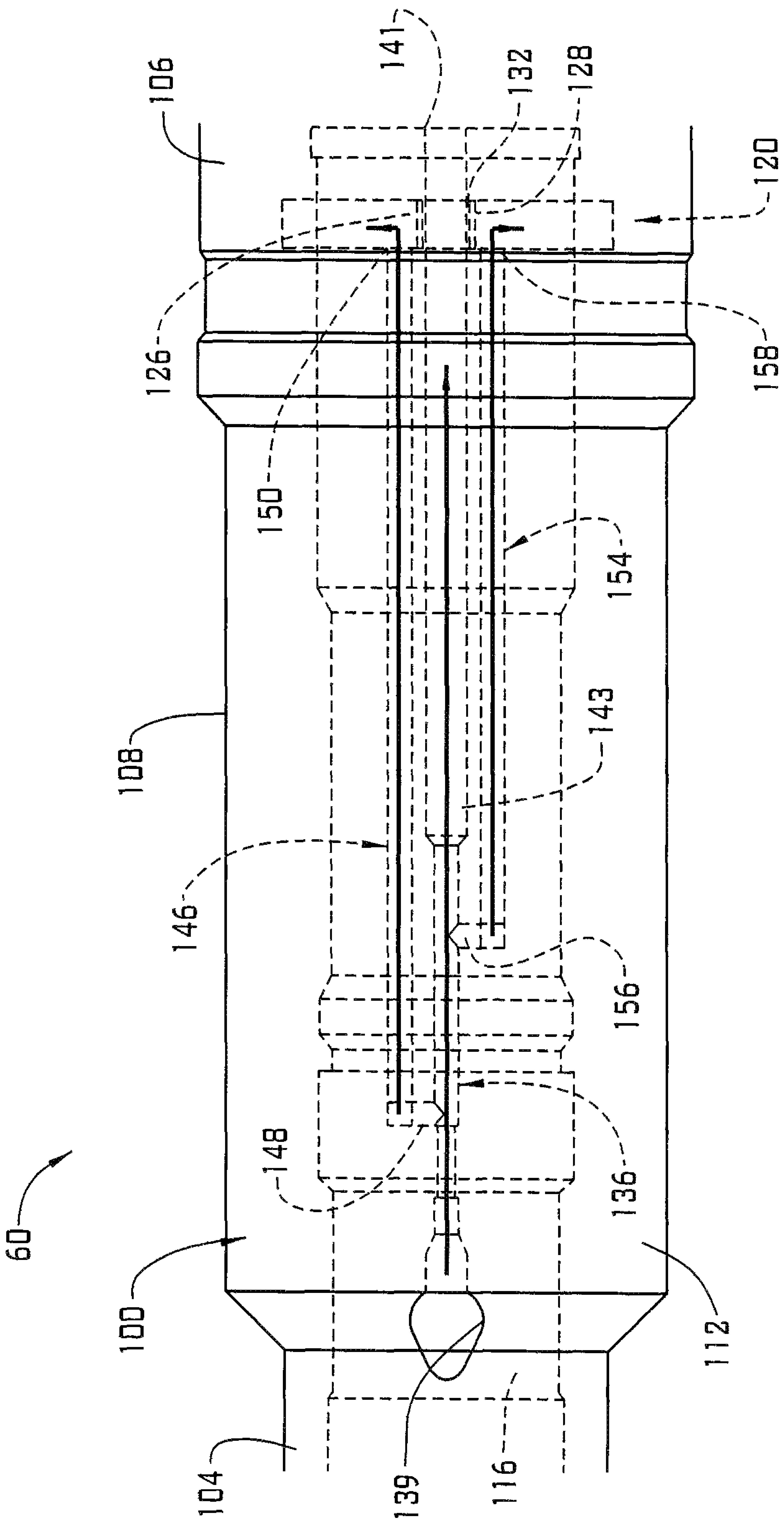
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FIG. 4

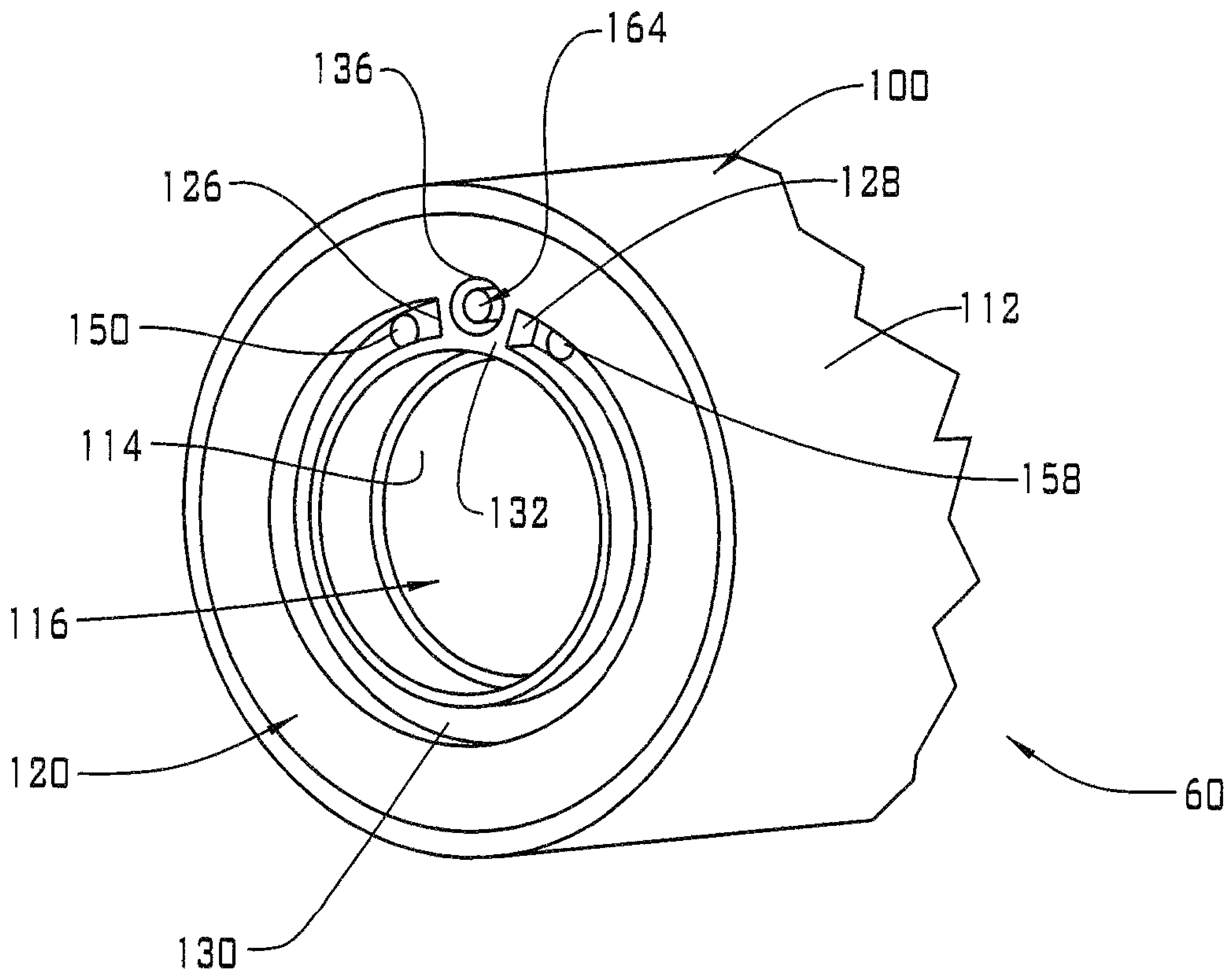

FIG. 5

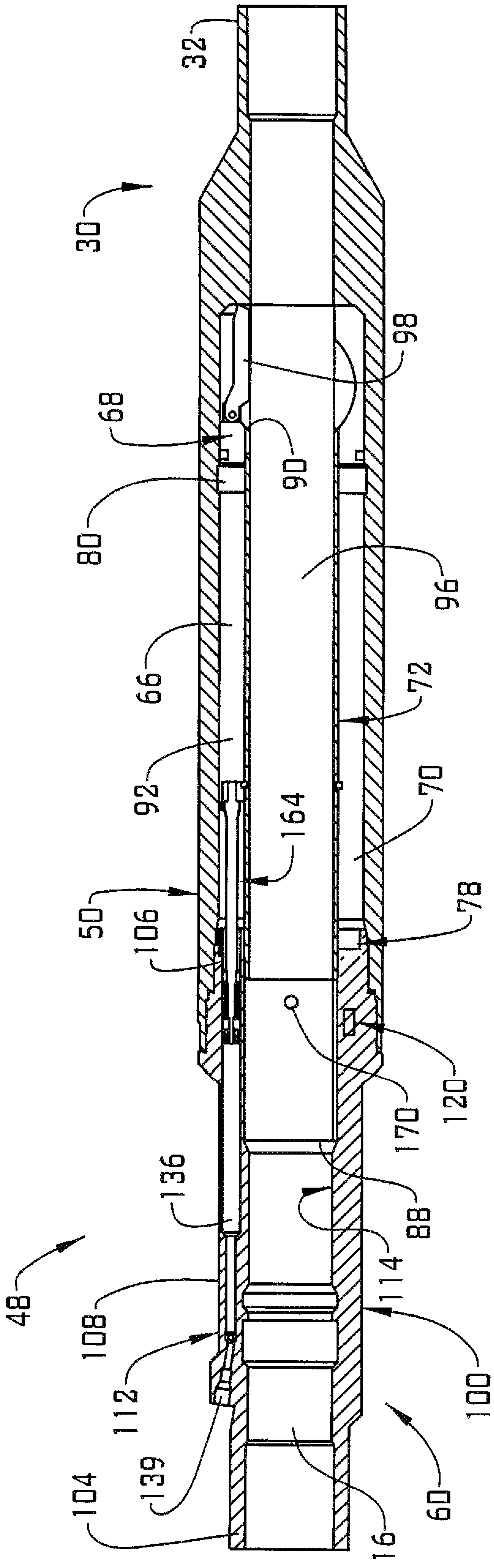
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FIG. 6

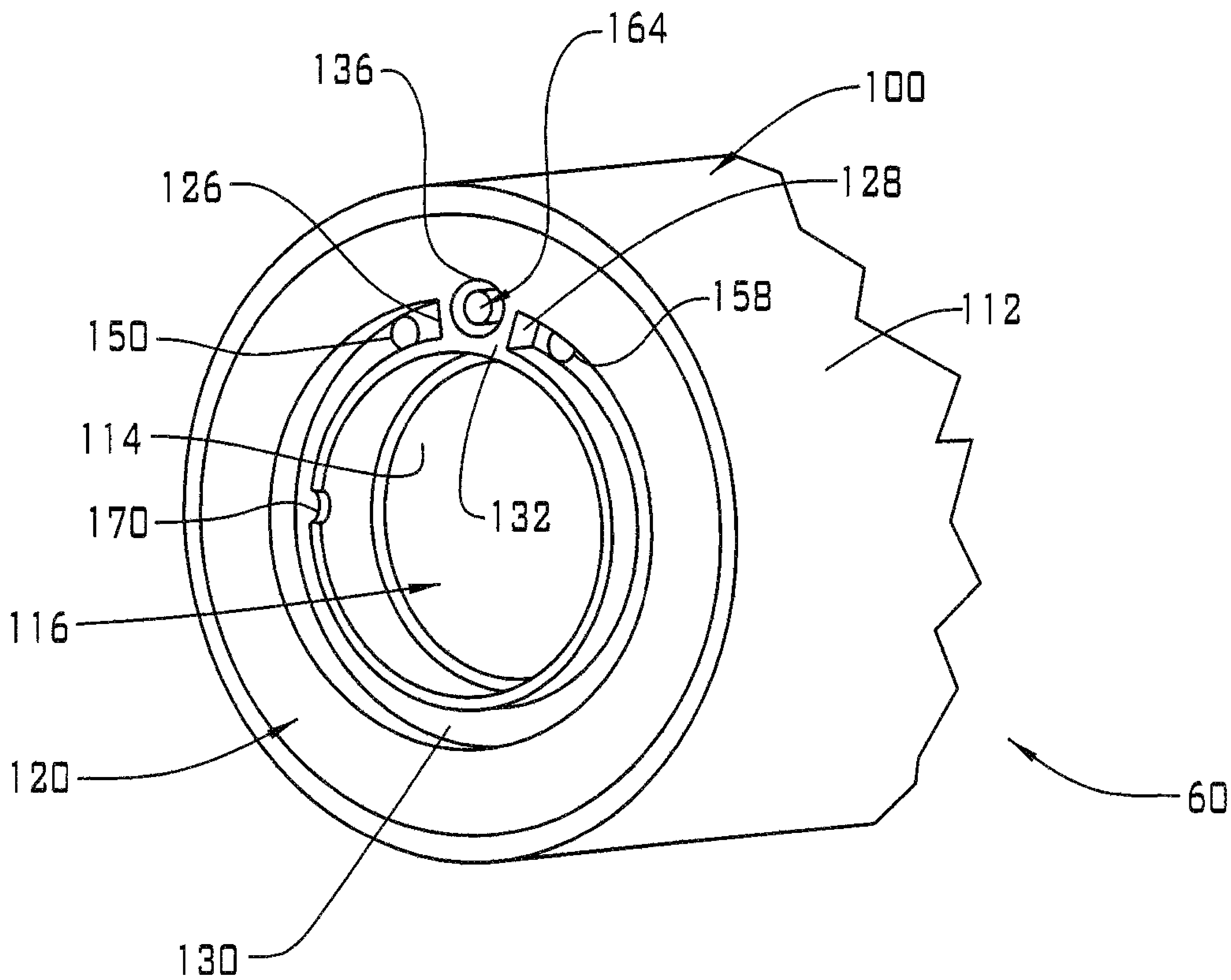

FIG. 7

DOWNHOLE COMPONENT INCLUDING A UNITARY BODY HAVING AN INTERNAL ANNULAR CHAMBER AND FLUID PASSAGES

BACKGROUND

In the resource exploration and recovery pressure chambers are often used to actuate various components. Often times, a control pressure may be applied to, for example, a piston supported in the pressure chamber. The piston may be used to selectively activate, for example, a subsurface safety valve. Of course, the control pressure may be employed to activate other subsurface devices. In some cases, the pressure chamber includes an annular chamber or a partially annular chamber that may be selectively punctured so that fluid may flow through the pressure chamber in the event of a piston failure.

Generally, the pressure chamber is part of a tool or conduit formed of at least two mated components. The partially annular chamber is formed in one, or both mating surfaces of the two mated components. A seal is provided to ensure that pressure and fluid do not breach a joint formed by joining the two mated components. The seal and joint represent a potential leak path. Additionally, forming mating components increases an overall cost and complexity of manufacture and maintenance. Therefore, the art would be appreciate a pressure chamber that includes fewer leak paths and which is more efficient to manufacture and maintain.

SUMMARY

Disclosed is a downhole component including a unitary body having a first end portion, a second end portion and an intermediate portion extending therebetween. The intermediate portion defines an outer surface and an inner surface forming a flow path. An annular chamber has a first end section spaced from a second end section by a gap. The annular chamber is formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface.

Also disclosed is a downhole system including a tubular having a tool mechanism and a downhole component mechanically connected to the tubular. The downhole component includes a unitary body having a first end portion, a second end portion and an intermediate portion extending therebetween. The intermediate portion defines an outer surface and an inner surface forming a flow path. An annular chamber has a first end section spaced from a second end section by a gap. The annular chamber is formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** depicts a resource exploration and recovery system including a downhole component including a unitary body having an internal annular chamber and fluid passages in accordance with an exemplary embodiment;

FIG. **2** depicts a downhole system including a tubular having a tool mechanism shown in a first position and a downhole component, in accordance with an exemplary aspect;

FIG. **3** depicts a downhole system including a tubular having a tool mechanism shown in a second position and a downhole component, in accordance with an exemplary aspect;

FIG. **4** depicts the downhole component, in accordance with an exemplary aspect;

FIG. **5** depicts a partial cross sectional perspective view of internal fluid passages of the downhole component of FIG. **4**;

FIG. **6** depicts the downhole system of FIG. **4** following a breaching operation; and

FIG. **7** depicts a partial cross sectional perspective view of an opening formed in the internal annular chamber following the breaching operation.

DETAILED DESCRIPTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

A resource exploration and recovery system, in accordance with an exemplary embodiment, is indicated generally at **10**, in FIG. **1**. Resource exploration and recovery system **10** should be understood to include well drilling operations, resource extraction and recovery, CO_2 sequestration, and the like. Resource exploration and recovery system **10** may include a first system **14** which, in some environments, may take the form of a surface system **16** operatively and fluidically connected to a second system **18** which, in some environments, may take the form of a downhole system. First system **14** may include a control system **23** that may provide power to, monitor, communicate with, and/or activate one or more downhole operations as will be discussed herein. Surface system **16** may include additional systems such as pumps, fluid storage systems, cranes and the like (not shown).

Second system **18** may include a tubular string **30**, formed from one or more tubulars **32**, which extends into a wellbore **34** formed in formation **36**. Wellbore **34** includes an annular wall **38** which may be defined by a surface of formation **36**, or a casing tubular **40** such as shown. In an exemplary aspect, tubular string **30** supports a downhole system **48** including a tubular **50** that houses a tool mechanism **54**. A downhole component **60** may be coupled with tubular **50** for purposes of activating tool mechanism **54**.

Referring to FIGS. **2** and **3**, tubular **50** includes an inner passage **66** within which resides tool mechanism **54**. In an embodiment, tool mechanism **54** is depicted as a subsurface safety valve (SSSV) **68**. However, it should be understood that tool mechanism **54** may take on various forms. Tool mechanism **54** also includes an actuator **70** including a flow tube **72** supported within inner passage **66** by a first support collar **78** and a second support collar **80**.

Flow tube **72** includes a first end **88**, a second end **90** and an intermediate section **92** that defines a conduit **96**. First support collar **78** is arranged at intermediate section **92** and second support collar **80** is arranged at second end **90**. First support collar **78** may be connected to downhole component **60** to axially shift flow tube **72** along inner passage **66**. More specifically, as will be detailed more fully herein, downhole component **60** shifts flow tube **72** into contact with a flapper **98** to shift SSV **68** from a closed configuration (FIG. **2**) to an open configuration (FIG. **3**).

Referring to FIGS. **4** and **5** and with continued reference to FIGS. **2** and **3**, downhole component **60**, in accordance with an exemplary aspect, includes a unitary body **100**. The term "unitary" should be understood to describe a component that is made as a single piece without joints, seams, or the like. In an embodiment, unitary body **100** is formed in an additive manufacturing process. Unitary body **100** includes a first end portion **104**, a second end portion **106** and an intermediate portion **108** extending therebetween. Unitary body **100** also includes an outer surface **112** and an inner surface **114** that defines a flow path **116** that registers with conduit **96**.

In accordance with an exemplary aspect, unitary body **100** includes an annular chamber **120**. Annular chamber **120** extends annularly about a portion of unitary body **100** between outer surface **112** and inner surface **114**. At this point, it should be understood that the term "annular" includes a full annular chamber e.g., a chamber that extends a full 360-degrees as well as partially annular chambers or chambers that extend less than a full 360-degrees. Annular chamber **120** includes a first end section **126**, a second end section **128** and an intermediate section **130**. First end section **126** is spaced from second end section **128** by a gap **132**. Annular chamber **120** is not exposed to flow path **116** during normal operating conditions. However, as will be discussed more fully herein, annular chamber **120** may be punctured and fluidically connected with flow path **116**.

In further accordance with an exemplary aspect, an axial passage **136** extends through unitary body **100**. Axial passage **136** includes a first end **139** exposed at outer surface **112**, a second end **141** that is exposed at second end portion **106** and an intermediate portion **143** that is formed between outer surface **112** and inner surface **114**. A first secondary axial passage **146** extends alongside axial passage **136**. First secondary axial passage **146** includes a first end section **148** fluidically connected to axial passage **136**, a second end section **150** fluidically connected to annular chamber **120**.

Additionally, a second secondary axial passage **154** extends alongside axial passage **136**. Second secondary axial passage **154** includes a first end section **156** fluidically connected to axial passage **136** between first end section **148** of first secondary axial passage **146** and annular chamber **120**. Second secondary axial passage **154** also includes a second end section **158** fluidically connected to annular chamber **120**. A piston **164** is arranged in axial passage **136** and is mechanically connected to first support collar **78**. Piston **164** may be acted upon by, for example, hydraulic pressure to shift flow tube **72** passed valve member **84** to open SSV **68**.

In accordance with an exemplary aspect, in the event that piston **164** becomes stuck, an opening **170** may be formed through annular chamber **120** to provide an auxiliary control flow path such as shown in FIGS. **6** and **7**. Specifically, a puncture communication tool (not shown) may be run down hole into axial passage **136**. The puncture communication tool may act upon a terminal end of piston **164** causing a radially outward puncture through annular chamber **120**. The radial outward puncture creates opening **170** to provide the auxiliary control flow path.

At this point it should be appreciated that the exemplary embodiments describe a downhole component having a unitary body that may function in a manner similar to previous components formed from multiple pieces. By creating a unitary body, leak paths are eliminated thereby decreasing maintenance and repair costs. Further, the formation of the unitary body allows the creation of multiple flow paths that were previously only achievable through the use of multiple components, complex machining operations, multiple seals and high assembly costs.

Set forth below are some embodiments of the foregoing disclosure:

Embodiment 1: A downhole component including: a unitary body including a first end portion, a second end portion and an intermediate portion extending therebetween, the intermediate portion defining an outer surface and an inner surface forming a flow path; and an annular chamber having a first end section spaced from a second end section by a gap, the annular chamber being formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface.

Embodiment 2: The downhole component as in any prior embodiment, further including: an axial passage including a first end exposed at the outer surface, a second end exposed at the second end portion, and an intermediate portion extending therebetween.

Embodiment 3: The downhole component as in any prior embodiment, further including: a piston arranged in the axial passage.

Embodiment 4: The downhole component as in any prior embodiment, further including: a first secondary axial passage formed in the unitary body, the first secondary axial passage including a first end section fluidically connected to the axial passage and a second end section fluidically connected to the annular chamber.

Embodiment 5: The downhole component as in any prior embodiment, further comprising: a second secondary axial passages formed in the unitary body, the second axial passage including a third end section fluidically connected to the axial passage and a fourth end section fluidically connected to the annular chamber.

Embodiment 6: The downhole component as in any prior embodiment, wherein the third end section is fluidically connected to the intermediate portion between the first end section and the annular chamber.

Embodiment 7: The downhole component as in any prior embodiment, wherein the unitary body is additively manufactured.

Embodiment 8: The downhole component as in any prior embodiment, wherein the annular chamber is selectively, fluidically connected to the flow path through the inner surface.

Embodiment 9: A downhole system including: a tubular including a tool mechanism; and a downhole component mechanically connected to the tubular, the downhole component including: a unitary body including a first end portion, a second end portion and an intermediate portion extending therebetween, the intermediate portion defining an outer surface and an inner surface forming a flow path; and an annular chamber having a first end section spaced from a second end section by a gap, the annular chamber being formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface.

Embodiment 10: The downhole system as in any prior embodiment, further including: an axial passage including a first end exposed at the outer surface, a second end exposed at the second end portion, and an intermediate portion extending therebetween.

Embodiment 11: The downhole system as in any prior embodiment, further comprising: a piston arranged in the axial passage.

Embodiment 12: The downhole system as in any prior embodiment, further comprising: an actuator operatively connected to the piston and the tool mechanism.

Embodiment 13: The downhole system as in any prior embodiment, wherein the tool mechanism comprises a subsurface safety valve (SSSV).

Embodiment 14: The downhole system as in any prior embodiment, wherein the actuator includes a tubular that is selectively shiftable through the SSSV.

Embodiment 15: The downhole system as in any prior embodiment, further comprising: a first secondary axial passage formed in the unitary body, the first secondary axial passage including a first end section fluidically connected to the axial passage and a second end section fluidically connected to the annular chamber.

Embodiment 16: The downhole system as in any prior embodiment, further comprising: a second secondary axial passage formed in the unitary body, the second secondary axial passage including a third end section fluidically connected to the axial passage and a fourth end section fluidically connected to the annular chamber.

Embodiment 17: The downhole system as in any prior embodiment, wherein the third end section is fluidically connected to the intermediate portion between the first end section and the annular chamber.

Embodiment 18: The downhole system as in any prior embodiment, wherein the unitary body is additively manufactured.

Embodiment 19: The downhole system as in any prior embodiment, wherein the annular chamber is selectively, fluidically connected to the flow path through the inner surface.

The use of the terms “a” and “an” and “the” and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should be noted that the terms “first,” “second,” and the like herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. The modifier “about” used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context (e.g., it includes the degree of error associated with measurement of the particular quantity).

The terms “about” and “substantially” are intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, “about” and/or “substantially” can include a range of ±8% or 5%, or 2% of a given value.

The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a wellbore, and/or equipment in the wellbore, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited.

What is claimed is:

1. A downhole component comprising:

a unitary body including a first end portion, a second end portion and an intermediate portion extending therebetween, the intermediate portion defining an outer surface and an inner surface forming a flow path; and

an annular chamber having a first end section spaced from a second end section by a gap, the annular chamber being formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface, wherein the annular chamber is selectively, fluidically connected to the flow path through the inner surface.

2. The downhole component according to claim **1**, further comprising: an axial passage including a first end exposed at the outer surface and a second end exposed at the second end portion.

3. The downhole component according to claim **2**, further comprising: a piston arranged in the axial passage.

4. The downhole component according to claim **2**, further comprising: a first secondary axial passage formed in the unitary body, the first secondary axial passage including a first end section fluidically connected to the axial passage and a second end section fluidically connected to the annular chamber.

5. The downhole component according to claim **4**, further comprising: a second secondary axial passage formed in the unitary body, the second axial passage including a third end section fluidically connected to the axial passage and a fourth end section fluidically connected to the annular chamber.

6. The downhole component according to claim **5**, wherein the third end section is fluidically connected to the axial passage between the first end section and the annular chamber.

7. The downhole component according to claim **1**, wherein the unitary body is additively manufactured.

8. A downhole system comprising:

a tubular including a tool mechanism; and

a downhole component mechanically connected to the tubular, the downhole component comprising:

a unitary body including a first end portion, a second end portion and an intermediate portion extending therebetween, the intermediate portion defining an outer surface and an inner surface forming a flow path; and

an annular chamber having a first end section spaced from a second end section by a gap, the annular chamber being formed in the unitary body spaced from the first end portion, the second end portion, the outer surface, and the inner surface, wherein the annular chamber is selectively, fluidically connected to the flow path through the inner surface.

9. The downhole system according to claim **8**, further comprising: an axial passage including a first end exposed at the outer surface and a second end exposed at the second end portion.

10. The downhole system according to claim **9**, further comprising: a piston arranged in the axial passage.

11. The downhole system according to claim **10**, further comprising: an actuator operatively connected to the piston and the tool mechanism.

12. The downhole system according to claim **11**, wherein the tool mechanism comprises a subsurface safety valve (SSSV).

13. The downhole system according to claim **12**, wherein the actuator includes an actuator tubular that is selectively shiftable through the SSSV.

14. The downhole system according to claim **9**, further comprising: a first secondary axial passage formed in the unitary body, the first secondary axial passage including a first end section fluidically connected to the axial passage and a second end section fluidically connected to the annular chamber.

15. The downhole system according to claim **14**, further comprising: a second secondary axial passage formed in the unitary body, the second secondary axial passage including a third end section fluidically connected to the axial passage and a fourth end section fluidically connected to the annular chamber.

16. The downhole system according to claim **15**, wherein the third end section is fluidically connected to the axial passage between the first end section and the annular chamber.

17. The downhole system according to claim **8**, wherein the unitary body is additively manufactured.

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